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**Final Report**

**National Aeronautics and Space Administration Grant NSG 1557**

**Studies of the Earth-Limb Absorptions in the Near Ultraviolet**

**Submitted by**

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## FINAL REPORT

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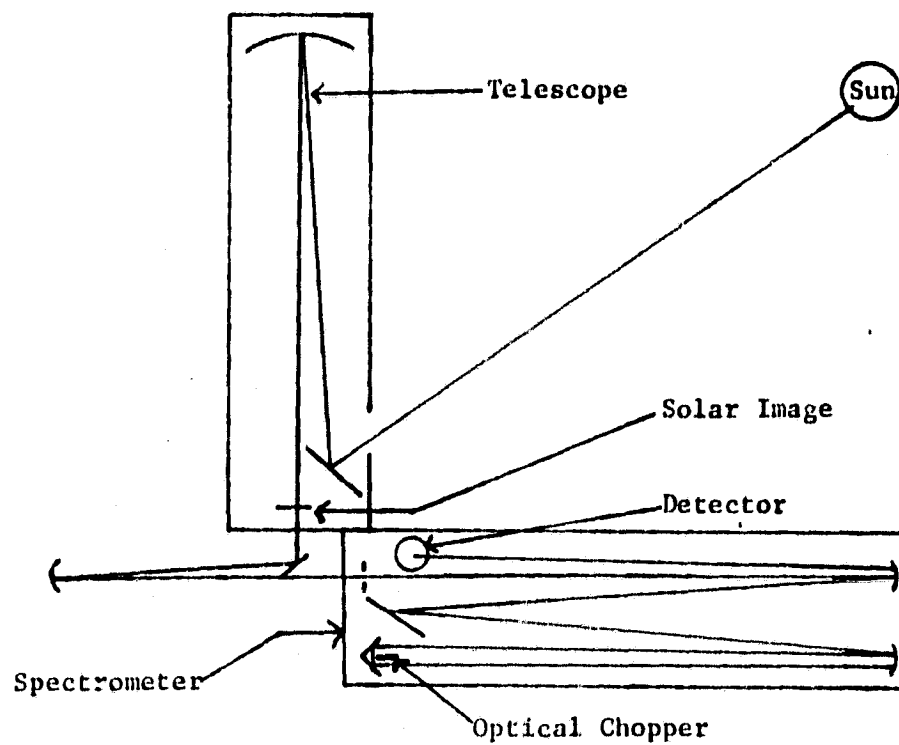
### Introduction:

Current interest in stratospheric photochemistry has led to the need for techniques to measure the stratospheric distribution of numerous species which are known or thought to be important in this chemistry; of particular interest to NASA are remote-sensing techniques since such techniques can be adapted to obtain the data on the constituent from satellites. Much effort has gone into testing solar occultation techniques as a means of obtaining data on a number of chemical species. In these tests emphasis has been placed on the infrared spectral region since a large number of molecular species have absorption bands in these wavelength regions. Some species of particular interest in the photochemistry of the ozone layer also have strong bands in the u-v visible region; thus, it may be possible to use these wavelength regions for such measurements. In order to test the feasibility of such a technique for OH, we assembled a balloon-borne system to obtain solar spectra in the region between 3080 Å and 3100 Å with a resolution of close to 0.05 Å. After assembling the instrumentation we performed a balloon flight with the system on October 10, 1979. The details of the instrumentation and the flight results are discussed in this report.

### Instrumentation:

The optical layout of the instrumentation used to obtain the appropriate solar spectra is shown in Figure 1. The characteristics of the spectrometer and the solar telescope system are given in Table I. The spectrometer is equipped with a photomultiplier detector and associated electronics necessary to amplify the output of the detector up to a level suitable for on-board recording and also for telemetering to the ground. The electronic schematic for the instrument is shown in Figure 2. The system is designed to operate from 28 vdc which is provided by a silver zinc battery pack. All units are mounted in a gondola system which provides the appropriate alignment of the units and also protects the system when it is returned to the ground by parachute after the balloon flight.

Figure 1. Optical Schematic of Telescope-Spectrometer System.



## High Resolution Balloon Borne UV Absorption Spectrometer

Table I. Systems Specifications

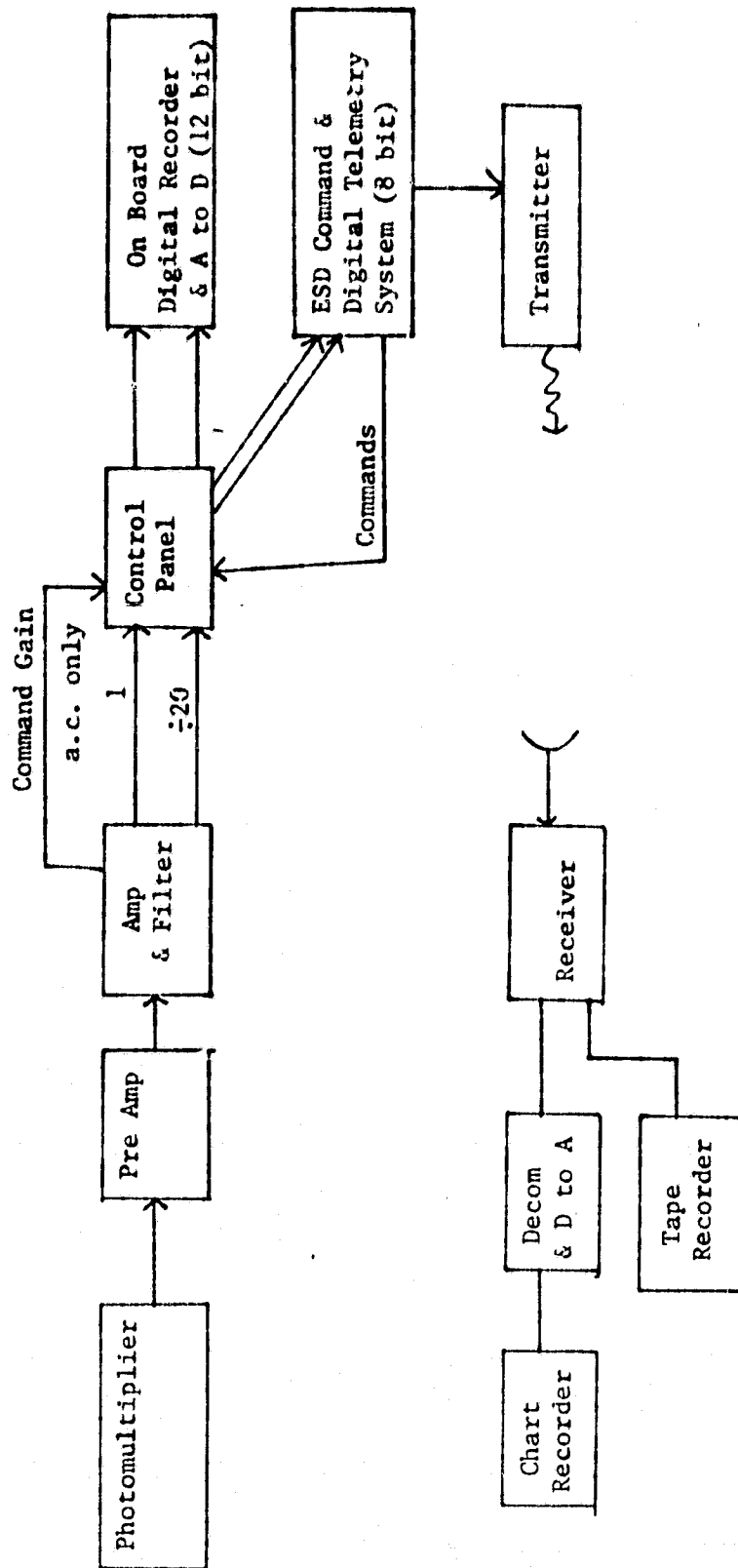
## A. Solar Telescope Tracking System

Primary Mirror: 10" dia., 56" focal length (f/5.6).  
Elevation Tracking: Plane elliptical mirror 10 x 15" with a  
3.2" dia. central hole.  
Azimuth Tracking: Telescope rotates about primary axis.  
Maximum Tracking Rate: 2 rpm.  
R.M.S. Tracking Error:  $\pm 3$  min. arc.  
Solar Image Size: 13 mm. dia.  
Weight: 120 lbs.

B. 1 $\frac{1}{2}$ m Czerny-Turner Grating Spectrometer

Mirrors: 2 - 9.4" dia. spherical mirrors, 2.5 m radius of curvature.  
Grating: B & L Echelle, 128 x 254 mm, blazed at  $63.5^\circ$  with 79  $\lambda$ /mm.  
Operating Order: 72nd for 3080  $\text{\AA}$  operation.  
No. of Passes of Grating: 2  
Slit Width: 150  $\mu$ m  
Slit Height: 10 mm  
Resolution: .04 $\text{\AA}$  @ 3080  $\text{\AA}$   
Throughput: 1 to 10%  
Detector: RCA C70042J  
Operating Mode: a.c. (optically chopped) or d.c.  
Blocking Filters: Corion 3083-26 & 3060-115  
Size: 12" x 27" x 60"  
Weight: 217 lbs.

Figure 2. Electronic Schematic of Spectrometer Detector and Data System.



Flight Details:

The system was flown from Holloman AFB on October 10, 1979. Launch was accomplished at 1600 MDT without incident. For this flight a  $3.69 \cdot 10^6 \text{ ft}^3$  balloon was used. This resulted in a float altitude of 33 km. The flight was terminated at 0130 October 11, 1979 when the balloon had reached a position where the equipment would impact in a good recovery area. The equipment was recovered in excellent condition. Everything worked very well and data were obtained from the ground through float and from float altitude during sunset.

Data Reduction:

One of the major problems in using the visible and ultraviolet portions of the solar spectrum for solar occultation measurements is the presence of the large number of absorption lines in this region due to atoms, molecules and ions in the solar atmosphere. These lines include absorption features due to solar OH which also interfere with those due to atmospheric OH lines. In theory the solar lines can be removed by ratioing solar spectra obtained from float altitude at high solar elevation angles with those obtained at low elevation angles. In practice this is complicated by the need to have absolutely accurate wavelength calibration in the two spectra which are being divided. Experimentally, such accuracy is not easily obtained and a major part of the data reduction effort has been devoted to achieving the desired accuracy in the wavelength calibration of each record under analysis. Once this was accomplished, the various solar spectra obtained during the sunset were divided by one obtained just after the balloon reached float altitude. Examination of these spectra revealed absorption features above the noise level due, apparently, to atmospheric OH. The analysis is complicated by the fact that the ozone absorption reduces the signal to noise in the spectra obtained at large solar zenith angle so that only those spectra obtained at solar zenith angles less than  $91^\circ$  can be used in the analysis.

Since the atmospheric optical path is increasing, the absorption should grow with increasing solar zenith angles. However, examination of the spectra show that the absorptions are decreasing as the solar zenith angle increases. The problem is that OH is generated photochemically and

model calculations indicate that the concentration should be changing rapidly during sunset. At the moment the analysis is continuing along two lines. Synthetic OH spectra are being calculated in order to assess the amount of OH required to produce the observed absorption. In addition, in order to validate the identification of the absorptions as being due to OH, synthetic spectra will be used to predict what additional OH lines should be present in the spectral region scanned during the flight and the spectra will be examined for these features.

Recommendations:

The float altitude chosen for this flight was 33 kms. At the time this appeared to be a good altitude to maximize the OH absorption and minimize the ozone interference. In fact, we underestimated the ozone interference and it is evident that future flights should be made using a larger balloon which would allow data to be obtained from a higher altitude. Thus, it is evident that obtaining the spectra from 40 km would increase the solar zenith angles for which data could be obtained and increase the OH absorption by a factor of 3 to 5 which should help to verify that the observed absorptions are in fact due to OH.